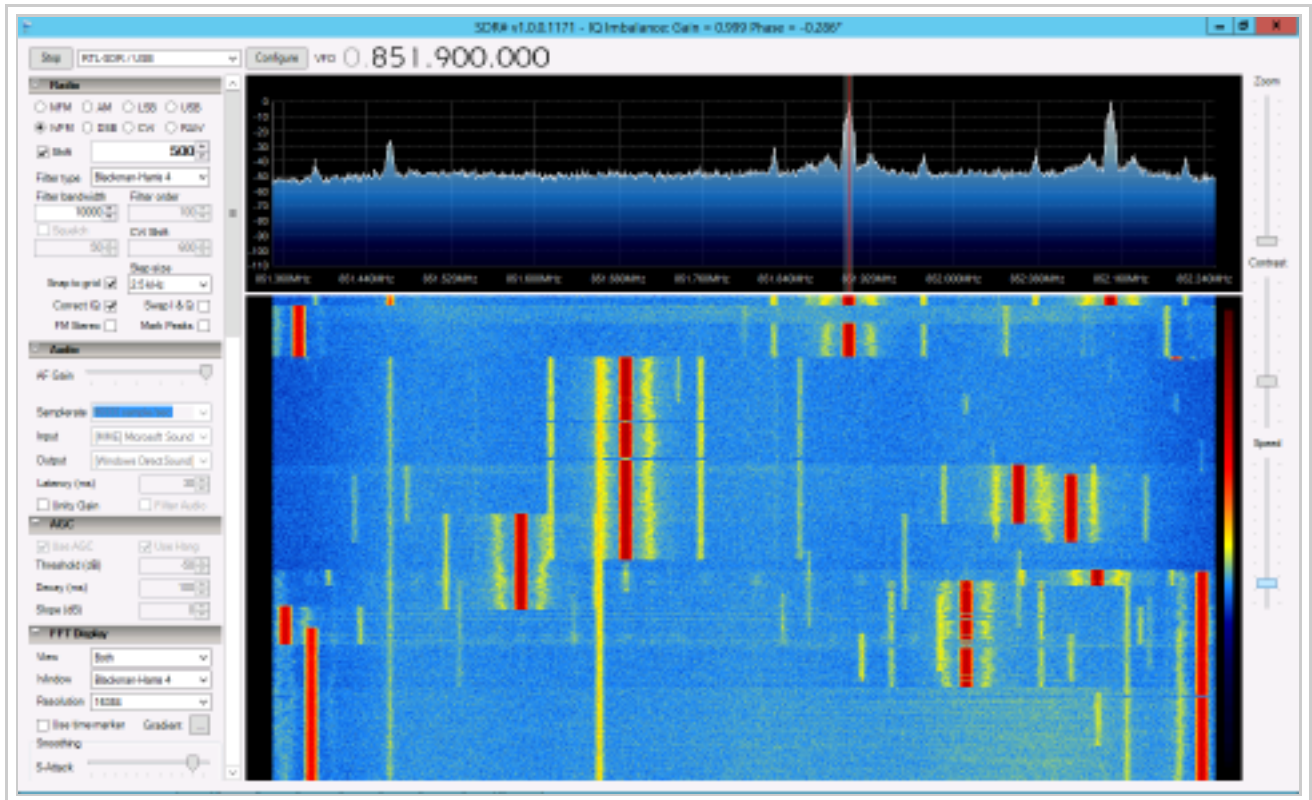
Software-defined radio

From /g/wiki

This article is written for beginners, higher level material can be found on using the links below



SDR# running in Windows 8

Software defined radio is the means of listening to radio waves using the combination of low level hardware, and software processing. While non-SDR techniques use physical hardware to demodulate FM and AM, In SDR raw data from the receiver gets sent into the USB port, and software is used to control the modulation. The only drawbacks of SDR are bandwidth constraints and processing. Since uncompressed unmodulated data is coming through a PC interface (USB mostly), a high speed connection and a computer with decent specs is required. A Single RTL-SDR May use up to 3.4MB/sec of USB bandwidth. CPU usage varies on the tuner software you use. Using software defined radio opposed to regular radio gives you the ability to see signals you would normally only hear. Your eyes can cover a very wide bandwidth of signals on a computer screen, while your ears can only comprehend a single spoken conversation at a time.

Contents

SDR models

SDRs come in many shapes in sizes, from the $8 RTL-SDR to $2000 USRP(with daughterboards) There are also many SDR's such as the HackRF, USRP, FunCube, etc.List of SDRs (https://en.wikipedia.org/wiki/List_of_software-defined_radios) When you buy an SDR, you get what you pay for. More expensive SDR's are purpose built for receiving, and can handle things such as GSM spoofing, where an unencrypted GSM tower can be simulated to capture SMS in a cleartext fashion.

RTLSDR

A great beginner SDR is the RTL-SDR It features a receive frequency range of 25-1700MHz, 2.048MHz bandwidth and is priced low enough that beginners can see whether radio is a hobby they want to get into(R820T model).

RTL-SDRs come with various tuner chips, the most widely used tuner is the R820T, with the E4000 coming in a close second. The E4000 is a discontinued model and is usually priced higher than R820T models. R820T tuners are generally better for reception of trunked radio systems (digital police radio).

Two common types of RTLSDRs

The RTLSDR began its life as a DVB-T OTA TV tuner (a tv tuner for europe). China began bulk manufacturing these TV tuners for the european market. It was later found that a hacked driver could be installed that let the user use the dongle as an SDR.

Currently R820T RTLSDRs can be bought for as low as $8 on eBay with free shipping R820Ts on eBay (http://www.ebay.com/sch/Computer-Components-Parts-/175673/i.html?_from=R40&LH_BIN=1&_sop=15&_nkw=r820t)

Funcube Dongle

As part of AMSAT-UK's FUNcube satellite project, the FUNcube Dongle is the "ground segment", or a radio receiver designed to allow anyone to try their hand at reception of satellites like FUNcube anywhere on Earth as part of a global educational collaboration project collecting information from space. The original has a frequency range of 64MHz to 1.7GHz. The Pro + has a frequency range of 150kHz to 240 MHz and 420MHz to 1.9GHz.

HackRF

The HackRF is a DARPA funded project, it aims to provide innovation and research in the SDR field. It's much more powerful than the RTL-SDR, much more sensitive, covers a greater frequency range. The HackRF starts at $300, has both RX and TX functionality from 30 MHz to 6 GHz, bandwidth of 20MHz. During DARPA funding, beta units, the HackRF Jawbreaker were given to hundreds of testers for free. The production version was funded through KickStarter. The campaign was successfully funded on September 4th 2013 and is currently available for purchase (http://greatscottgadgets.com/hackrf/)

> **Transmitting**
> TX functionality on the HackRF is limited in power because RF theory says you must have an antenna length that corresponds to the wavelength you are sending. For example sending 5Watts over the wrong size antenna will cause a buildup of standing waves, and may fry the transmitter. To prevent this, the antenna build into the breadboard of the HackRF is only designed for ultra low power, good enough for experimentation, but not for serious broadcasting.

Possibilities

SDR's have endless possibilities. Because all demodulation is done in software, no new hardware is needed to decode, for example, a new digital voice mode. All the programmer has to do is write code to convert the raw samples from USB to the correct format data.

SDR# FAQ

Full article (http://tylerwatt12.com/tips-for-using-sdr/)

- I hear FM radio stations from 25-86MHz
  - That is your SDR being overloaded by FM broadcast signal, try installing an FM trap or lowering your gain.
- I see signals that go the opposite way from where i'm dragging
  - That is interference, not an actual signal, lowering your gain solves this

- I see a spike in the middle of the screen
  - This is the DC spike, a side effect of the RTLSDR, check the box that says Correct IQ

- I see lots of interference in the 100-150MHz band
  - It's common to see interference when the antenna is placed near networking equipment, wireless routers and computers. Move the antenna away from these sources to lower the effect

Modulation guide

Some frequencies are used by only one type of modulation. For example 88-108 is broadcast FM, the modulation used is WFM. Using the correct modulation can help you decide what type of signals you are listening to. The table below lists the most common modulations.

Frequency	Modulation
0-50MHz	AM, SSB, USB, LSB
88-108MHz	WFM
120MHz	AM (Airband)
120-980MHz	NFM

Getting Started with RTLSDR

AM vs FM

Points of interest

- Points of interest are bolded

MF(Shortwave Radio)

An upconverter is required to listen to these frequencies

HF (3-30MHz)

An upconverter is required to listen to most of these frequencies

VHF(30-300MHz)

- 30–46 MHz: Licensed 2-way land mobile communication.
- 30–88 MHz: Military VHF-FM, including SINCGARS
- 43–50 MHz: **Cordless telephones, 49 MHz FM walkie-talkies and radio controlled toys, and mixed 2-way mobile communication.** The FM broadcast band originally operated here (42-50 MHz) before moving to 88-108 MHz.
- 50–54 MHz: Amateur radio 6 meters band
- 54-72 and 76-88 MHz TV channels 2 through 6 (VHF-Lo), known as "Band I" internationally; some DTV stations will appear here. See North American broadcast television frequencies
- 72–76 MHz: Radio controlled models, industrial remote control, and other devices. Model aircraft operate on 72 MHz while surface models operate on 75 MHz in the USA and Canada, air navigation beacons 74.8-75.2 MHz.
- 87.5–108 MHz: FM radio broadcasting (87.5–91.9 non-commercial, 92–108 commercial in the United States) (known as "Band II" internationally)
- 108–118 MHz: Air navigation beacons VOR

- 118–137 MHz: **Airband for air traffic control**, AM, 121.5 MHz is an emergency frequency
- 137-138 Space research, space operations, meteorological satellite
- 138–144 MHz: Land mobile, auxiliary civil services, satellite, space research, and other miscellaneous services
- 144–148 MHz: Amateur radio 2 Meters band
- 148-150 MHz: Land mobile, fixed, satellite
- 150–156 MHz: **"VHF business band," public safety, the unlicensed Multi-Use Radio Service (MURS), and other 2-way land mobile, FM**
- 156–158 MHz VHF Marine Radio; narrow band FM, 156.8 MHz (Channel 16) is the maritime emergency and contact frequency.
- 159.81-161.565 MHz Railways 159.81-160.2 are railroads in Canada only and is used by trucking companies in the U.S.
- 160.6-162 Wireless microphones and TV/FM broadcast remote pickup
- 162.40–162.55: **NOAA Weather Stations**, narrowband FM
- 174-216 MHz television channels 7 - 13 (VHF-Hi), known as "Band III" internationally. A number of DTV channels have begun broadcasting here, especially many of the stations which were assigned to these channels for previous analog operation.
- 174–216 MHz: professional wireless microphones (low power, certain exact frequencies only)
- 216–222 MHz: land mobile, fixed, maritime mobile,
- 222–225 MHz: 1.25 meters (US) (Canada 219-220, 222-225 MHz) amateur radio

UHF(300MHz-3GHz)

- 225–420 MHz: Government use, including meteorology, military aviation, and federal two-way use
- 420–450 MHz: Government radiolocation and amateur radio (70 cm band)
- 433 MHz: **Short range consumer devices including automotive, alarm systems, home automation, temperature sensors**
- 450–470 MHz: **UHF business band, General Mobile Radio Service, and Family Radio Service 2-way "walkie-talkies", public safety**
- 470–512 MHz: TV channels 14–20 (also shared for land mobile 2-way radio use in some areas)
- 512–698 MHz: TV channels 21–51 (channel 37 used for radio astronomy)
- 698–806 MHz: Was auctioned in March 2008; bidders got full use after the transition to digital TV was completed on June 12, 2009 (formerly UHF TV channels 52–69)
- 806–824 MHz: Public safety and commercial 2-way (formerly TV channels 70–72)
- 824–851 MHz: Cellular A & B franchises, terminal (mobile phone) (formerly TV channels 73–77)
- 851–869 MHz: Public safety and commercial 2-way (formerly TV channels 77–80)
- 869–896 MHz: Cellular A & B franchises, base station (formerly TV channels 80–83)
- 902–928 MHz: **ISM band, amateur radio (33 cm band), cordless phones and stereo, radio-frequency identification, datalinks**
- 929–930 MHz: **Pagers**
- 931–932 MHz: **Pagers**
- 935–941 MHz: **Commercial 2-way radio**
- 941–960 MHz: Mixed studio-transmitter links, SCADA, other.
- 960–1215 MHz: Aeronautical Radionavigation
- 1090 MHz: ADS-B Commercial airplane beacons
- 1240–1300 MHz: Amateur radio (23 cm band)
- 1452–1492 MHz: Military use (therefore not available for Digital Audio Broadcasting, unlike Canada/Europe)
- 1710–1755 MHz: AWS mobile phone uplink (UL) Operating Band
- 1850–1910 MHz: PCS mobile phone—order is A, D, B, E, F, C blocks. A, B, C = 15 MHz; D, E, F =

5 MHz
- 1920–1930 MHz: DECT Cordless telephone
- 1930–1990 MHz: PCS base stations—order is A, D, B, E, F, C blocks. A, B, C = 15 MHz; D, E, F = 5 MHz
- 2110–2155 MHz: AWS mobile phone downlink (DL) Operating Band
- 2300–2310 MHz: Amateur radio (13 cm band, lower segment)
- 2310–2360 MHz: Satellite radio (Sirius and XM)
- 2390–2450 MHz: Amateur radio (13 cm band, upper segment)
- 2400–2483.5 MHz: ISM, IEEE 802.11, 802.11b, 802.11g, 802.11n Wireless LAN, IEEE 802.15.4-2006, Bluetooth, Radio-controlled aircraft, Microwave oven, ZigBee

Upconverters

Software

Software is available for Windows, GNU/Linux and OSX.

SDR Software (The stuff you listen with)

Software	Supported Modes	OS	Cost/License	Features/Limitations
SDR Touch	AM, WFM, NFM, SSB, DSB, CW	Android	Freemium, Closed	supports RTL_TCP and USB OTG, FFT times out after 30 seconds on free version
glSDR	AM, WFM, NFM, SSB, DSB, CW, DIG(?), SPEC(?), SAM(?), DRM	Android	Free, GNU/GPL	UI for ghpsdr servers
SDR-Radio		Windows	Free, Closed	Feature packed, harder to get set up
SDR-Radio v2		Windows	Free possibly paid out of beta, Closed	Beta, Feature packed, supports RTL_TCP
SDR#		Windows	Free, MS-RSL/MIT	Most popular and easiest to use
HD-SDR		Windows	Free, Closed	
PowerSDR		Windows	Free, GNU/GPL	Does not support RTL-SDR
GQRX	AM, WFM, NFM, SSB, CW, AFSK1200	Win,Lin,Mac	Free, GNU/GPL	Runs on GNU Radio
GNU Radio		Win,Lin,Mac	Free, GNU/GPL	Tools to build your own receiver. Versatile, larger learning curve.
Linrad		Win,Lin,Mac	Free, OSS	
Studio1			Paid,Closed Source	Formerly WRPLUS

Plugins for SDR#

Purpose	Software	Cost/License
Scan and log various frequencies	Frequency Manager + Scanner plugin	Free, OSS
Tune SDR# to the approprate voice channel	Trunking plugin for SDR#	Free, OSS

HF decoders (shortwave 0-30MHz)

Purpose	Mode	Software	OS	Cost/License	Common Frequency
Digital decoding on HF	CW, Domino, Hell, MFSK, PSK, OLIVIA, RTTY, Throb, Thor, WWV	Fldigi	Win,Lin,Mac	Free, GNU/GPL	0-30MHz AM
HF amateur radio codec	FreeDV, Codec2	FreeDV	Win,Lin,Mac	Free, GNU/GPL	0-30MHz AM
Digital broadcast shortwave	DRM	Dream	Win,Lin,Mac	Free, GNU/GPL	0-30MHz AM
Sending images over HF, commonly QSLs	Robot, AVT, Scottie, Martin	MMSSTV	Windows	Free, OSS	0-30MHz AM

ADS-B Airplane tracking software

Purpose	Mode	Software	OS	Cost/License	Frequency
Plane-spotting, decoding ADS-B	ADS-B	ADSB#	Windows	Free, MIT	1090MHz AM
Decodes ADSB# data + Plot planes on a map	AVR-BEAST	VirtualRadar Server	Windows	Free, OSS	1090MHz AM
Alternative to ADS-B#	ADS-B	RTL1090	Windows	Free, Closed	1090MHz AM
Decodes ADSB (S Mode)	ADS-B	Dump1090	Linux	Free, BSD	1090MHz AM

APRS (like GPS, hams use it)

Purpose	Mode	Software	OS	Cost/License	Frequency
Amateur packet radio incl. GPS location	AX.25, AFSK, APRS	AFSK1200	Win,Lin,Mac	Free, GNU/GPL	144-145MHz FM, Varies

Trunked Radio (police fire and EMS in urban areas)

Purpose	Mode	Software	OS	Cost/License	Frequency
Decode control	P25, EDACS48, EDACS96,				Usually

channel data	Motorola, MPT1327	Unitrunker	Windows	Free, Closed	400MHz, 760,860,933MHz FM
Decode digital voice	P25p1, ProVoice, X2-TDMA, DMR/MOTOTRBO, NXDN	DSD	Win,Lin,Mac	Free, BSD	Usually 400MHz, 760,860,933MHz FM
Decode LTR data	LTR	LTR Analyzer	Windows	Free, Unknown	~400-500MHz

NOAA weather satellite

Purpose	Mode	Software	OS	Cost/License	Frequency	Other
Decode NOAA WX images	APT, WEFAX	WxtoIMG	Win,Lin,Mac	Freemium, Closed	~137MHz FM	Track Live
Decode NOAA Satellite	APT	Atpdec	Linux	Free, GPL	~137MHz FM	

Television (non digital kind)

Purpose	Mode	Software	OS	Cost/License	Frequency
Analog television decoder, no sound	NTSC, PAL	TVSharp	Windows	Free, OSS	Any AM (including ISM security cameras)

Pagers

Purpose	Mode	Software	OS	Cost/License	Frequency
Decode various pager formats	POCSAG, FLEX	PDW	Windows	Free, GNU/GPL	35-45MHz, 152-160MHz, 455-463MHz, 928-932MHz FM
Decode various including pager	POCSAG	multimon-ng	Linux	Free, GPL	various

Audio routing software

Purpose	Software	Cost/License
Routes audio from the receiver to a decoder software above	Virtual Audio Cable	Shareware, Closed $35
Routes audio from the receiver to a decoder software above	VB Audio Cable	Donationware, Closed ($5 donation gets you more cables)

Video Tutorials

SDRSharp (Windows) (https://www.youtube.com/watch?v=ySm9mjCmq0g)

GnuRadio (Linux) (https://www.youtube.com/watch?v=A49SuAyrPh4)

Trunking police scanner (Windows) (https://www.youtube.com/watch?v=7VObj8JVLME)

Other SDR resources

/r/RTLSDR on Reddit (http://reddit.com/r/rtlsdr)

Scanner centric SDR discussion forums on RadioReference (http://forums.radioreference.com/software-defined-radio/)

FCC website, every RF transmitter registered registered with the FCC resides in this database (http://wireless2.fcc.gov/UlsApp/UlsSearch/searchGeographic.jsp)

An online SDR receiver that covers the HF band (shortwave, worldwide transmissions) (http://websdr.ewi.utwente.nl:8901/)

2011 US frequency allocation chart PDF (http://www.ntia.doc.gov/files/ntia/publications/spectrum_wall_chart_aug2011.pdf)

Retrieved from "https://wiki.installgentoo.com/index.php?title=Software-defined_radio&oldid=5286"
